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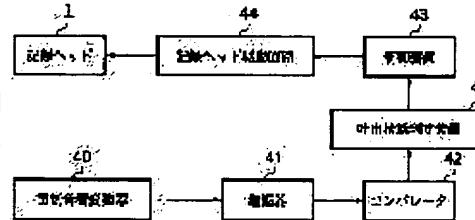
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## (54) INK JET RECORDING METHOD AND INK JET RECORDER

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To reduce the running cost by detecting an acoustic signal produced from a bubble, controlling the recording operation based on the decision results of ejecting state of ink and discharging only thickened ink in a nozzle at the time of preliminary ejecting or replacing ink thereby reducing the quantity of ink to be discharged.

**SOLUTION:** A piezoelectric electroacoustic converter 40 is fixed closely to a heating element in order to detect a sound wave produced from a bubble heated by the heating element and the detected sound wave is fed through an amplifier 41 to a comparator 42. A ejecting state decision unit 45 decides the ejecting state based on the output from comparator 42 and delivers a preliminary ejecting sustention signal to a recording operation controller 43 when the ink ejecting state is normal otherwise delivers a stop signal. Since only a thickened ink in each liquid channel can be ejected surely regardless of the environmental fluctuation or the difference in the extent of evaporation of volatile component in the ink, quantity of ink can be reduced at the time of preliminary ejecting.



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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the appearance perspective diagram of an ink-jet recording device.

[Drawing 2] It is the appearance perspective diagram of a recording head.

[Drawing 3] It is the cross-sectional view of a recording head.

[Drawing 4] It is the block diagram of an ink-jet recording device.

[Drawing 5] It is an output signal view from a comparator.

[Drawing 6] It is a control flow chart.

[Drawing 7] It is an output signal view from amplifier.

[Drawing 8] It is the block diagram of an ink-jet recording device.

[Description of Notations]

1 Recording Head

2 Carriage

3 Guide Shaft

4 Encoder

40 electroacoustic transducers

41 amplifier

42 comparators

45 discharge-condition judging equipment

43 control units

44 recording head drive circuits

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[Translation done.]

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the technology of starting the ink-jet record method and an ink-jet recording device, especially performing the ink regurgitation using heat energy.

[Description of the Prior Art] Since an ink-jet recording device has many advantages, such as good [ of a printing grace result ], speed of record operation, and silence at the time of operation Replace with the wire dot printer which was in use, and have come to be used mostly in recent years. The Bubble Jet (BJ method is called hereafter) which especially performs the ink regurgitation with the pressure which becomes an applicant for this patent, and which ink was made to foam using heat energy and was generated in the instant Since the on-demand record by the high-density multi-nozzle is possible, an ink-jet recording method is in use. However, there is a technical technical problem of the characteristic following in this BJ method.

[0002] That is, if the state where ink is not made to breathe out continues over a long period of time while it has been in the state where it filled up with ink in the nozzle, as 1st technical technical problem, the water which is a volatile component in ink, the alcohols of low molecular weight, etc. will evaporate gradually through an ink delivery, and the viscosity of the ink in a nozzle will rise. Consequently, in order for the passage resistance at the time of ink flowing to increase the inside of a nozzle and to make ink breathe out, even if it uses heat energy and makes an ink foam generate, it comes to be hard to carry out the regurgitation of the ink.

[0003] The fall of the regurgitation speed of ink will be caused, an ink impact position will shift from a position, or the discharge quantity itself will decrease [ the flight direction of regurgitation ink becomes easy to shift from a predetermined direction, ], and this has a possibility that predetermined picture concentration may no longer be obtained. furthermore -- if evaporation of a volatile component advances -- just -- being alike -- even if it makes a foam generate in ink, ink breathes out and twists and lapses into a state

[0004] Since ink will thicken even if it is going to resume record operation, after 1 state where it does not record continues for a long time if the above is summarized, breathe out normally and there is nothing. While thickening is advancing extremely, completely breathe out and there is nothing.

2) record -- working -- setting -- image data -- although a part of nozzle which will be in the state where ink is not made to breathe out over a long time will be made in how, since ink will thicken also in such a nozzle, even if a printing signal is inputted next according to image data, ink may breathe out normally and may be lost While thickening is advancing extremely, it completely breathes out and is lost.

[0005] The following measures are taken to these.

[0006] First, to 1, it changed into the state where the cap was contacted to the nozzle nose of cam at the time of non-recording operation and evaporation of the volatile component of the ink from a delivery is prevented to suppress evaporation of the volatile component of the ink from a delivery. As the vapor rate of a volatile component is made late, in humid our country, it can be made to perform sufficient dryness

prevention by this method. However, in many foreign countries where humidity is low, by the case where it is not used over a long period of time, since evaporation of a volatile component may advance and the viscosity of ink may rise, in such a case, it corresponds in attracting ink, or carrying out pressurizing ink from an ink supply system etc. through a cap, and replacing the ink in a nozzle by the fresh thing.

[0007] However, as for performing this frequently, it is not desirable to replace ink as mentioned above in order to consume a lot of ink. Then, in order to make it for ink to breathe out and not lost by evaporation of the volatile component in ink, the regurgitation of ink is preparatorily performed for every predetermined time, the ink from which the component changed is discharged to the exterior of a nozzle, and the record method which always maintains ink at the state in which the regurgitation is possible is performed (this is called cure 1a).

[0008] This cure 1a has the advantage that there are very few amounts of ink discharged in one operation compared with the method of replacing ink as mentioned above.

[0009] Moreover, the method of performing the reserve regurgitation and keeping the grace of a record picture proper further, just before starting record operation when record operation is resumed, even if it does not reach a predetermined time is also performed (this is called cure 1a+).

[0010] Moreover, after changing ink viscosity into a proper state as a recording head is evacuated even to a non-record section and the ink reserve regurgitation is performed in this non-record section whenever a recording head carries out the number-of-times part scan of predetermined of the record-medium-ed top to 2, the method of resuming record operation and maintaining a suitable image recording state is performed, and it is. However, since the throughput of image recording may fall according to this method Only when the nozzle in the state where memorize the ink regurgitation history of each nozzle and ink is not made to breathe out more than over a predetermined time occurs After evacuating a recording head to a non-record section, performing the ink reserve regurgitation in this field and changing ink viscosity into a proper state, the method of resuming record operation has been performed (this is called cure 1b).

[0011] Whenever it carries out the number-of-times scan of predetermined according to this cure 1b, rather than the method of performing the ink reserve regurgitation, the amount of \*\*, Inc. can be saved, is united and the fall of the throughput of image recording can also reduce it.

[0012] The following sudden abnormalities in the regurgitation arise during record operation, therefore it may be able to stop being able to maintain proper image recording as 2nd technical technical problem.

[0013] 1) The ink in which near a delivery gets wet in ink and is breathed out by this will be caught, and it will be in an ink non-discharge condition.

[0014] 2) It is in a bubble or a dust plugging state, or when a multi-nozzle is simultaneously started by high duty, the ink short supply to a nozzle arises, and the ink regurgitation becomes unusual as a result of making a foam generated still in the state in the state where a nozzle is not completely filled up with ink.

[0015] 3) During record operation, ink is consumed completely, will be in an empty state, and becomes unrecordable from the middle of image recording.

[0016] The following measures are taken to these technical technical problems.

[0017] To 1), whenever it carries out the scan of the record-medium top several times, the delivery side of a recording head is wiped using a flexible member, and the ink adhering to the delivery is removed (this is called cure 2a).

[0018] In order to supply to 2) after a filter removes the dust in the ink of a recording head, or to make it the structure where a bubble cannot collect easily or to make it supply of ink meet the deadline also at the time of a high duty drive, an elastic member is prepared in a liquid room (this is called cure 2b).

[0019] 3) Ink residue detection equipment is formed in the ink tank or the recording head, and this performs ink residue detection, stop record before being lost completely, take out warning to a user, and urge him to exchange exchange of an ink cartridge, or the recording head of an ink cartridge and integral construction (this is called cure 2c).

[0020]

[Problem(s) to be Solved by the Invention] Although it is fully satisfied [ with the bottom of a normal operating environment ] of specification with the above-mentioned each set policy, in order to satisfy stringent specification more, it is necessary to solve the following troubles. Namely, the reserve regurgitation is performed for every predetermined time as a problem in one cure 1a and 1a+. In order to change all nozzles into the state in which the regurgitation of ink is certainly possible, (cure 1a), It is necessary to set up time (following and regurgitation possible standby time) after stopping the regurgitation of ink for the time interval (henceforth, reserve \*\*\*\*\*) which performs the reserve regurgitation until ink is breathed out and lost by evaporation and thickening according to the shortest environmental condition. Furthermore, you also have to set the number of times which makes the thickening ink in each nozzle breathe out as the number of times by which the thickening ink in a nozzle is fully discharged under this condition.

[0021] If it does in this way, when evaporation of the volatile component in [ such as the bottom of a high-humidity environment, ] ink is slow, even if it is the case where ink thickening in a nozzle is seldom advancing, the ink reserve regurgitation will be performed. It will discharge in large quantities even in the ink which will not be thickened if the ink in a nozzle is made to breathe out by the above-mentioned number of times at this time.

[0022] Furthermore, although the 1st reserve regurgitation after a record operation end needs to perform the reserve regurgitation within the nozzle (nozzle which was not making ink completely breathe out a certain amount of time before record operation end most extremely) regurgitation possible standby time which was making ink breathe out by low duty before a record operation end At this time, the ink which is not thickened like the reserve regurgitation under the late environment of the above-mentioned evaporation will be thrown away in large quantities with the nozzle which was breathing out ink by high duty before the record operation end.

[0023] Moreover, since ink is made breathed out by the number of times more than required in case the reserve regurgitation is performed just before a recording start (cure 1a+) when time has seldom passed since reserve discharging, time until it goes into record operation becomes long.

[0024] Therefore, since the number of times which a running cost becomes [ number of times ] high and makes a foam generate by reserve discharging since it will be thrown away according to cure 1a+, without sufficiently usable ink being used for proper image recording by record increases, there is a heater life also with a bird clapper short. Furthermore, power consumption may become large, the time to resumption of record operation may become long, and the throughput of image recording may fall.

[0025] 2) As a trouble in cure 1b, by memorizing the regurgitation history of each nozzle In order to grasp the time which does not make ink breathe out, to perform the reserve regurgitation so that this may not exceed predetermined time, and to change all nozzles into the state in which the regurgitation of ink is certainly possible It is necessary to set up time (following and regurgitation possible standby time) after stopping the regurgitation of ink for reserve \*\*\*\*\* until ink is breathed out and lost by evaporation and thickening according to the shortest environmental condition. Furthermore, you also have to set the number of times which makes the thickening ink in each nozzle breathe out as the number of times by which the thickening ink in a nozzle is fully discharged under this condition.

[0026] The reserve regurgitation will be performed while thickening of the ink in a nozzle will seldom advance in the bottom of a high-humidity environment etc. when evaporation of the volatile component in ink is slow, if it does in this way. At this time, even the ink which will not be thickened if the ink in a nozzle is made to breathe out by the above-mentioned number of times will discharge in large quantities.

[0027] Therefore, according to cure 1b, for proper image recording, it will be thrown away without using usable ink for record, and a running cost may become high, the number of times which makes a foam generate by reserve discharging may increase, a heater life may become short, and power consumption may become large. And the time to resumption of record operation may become long, and the throughput of image recording may fall.

[0028] 3) If a image recording is interrupted frequently and a delivery side is cleaned as a trouble in cure

2a, the throughput of image recording will fall.

[0029] b) that the amniorrhesis material currently formed in the delivery side will peel if the delivery side of a recording head is frequently wiped with a member \*\*\*\* -- getting damaged -- etc. -- generate, the configuration of a delivery changes and "depend" etc. becomes easy to happen [ of regurgitation ink ]

[0030] c) Although the probability that the sudden non-regurgitation by ink wetting will happen can be reduced, it is not theoretically made to "zero."

[0031] d) The non-regurgitation once happens and the confused picture cannot be restored.

[0032] 4) as a trouble in cure 2b, only by making it low, cure 2b does not happen fundamentally and is carrying out probability that a phenomenon will happen -- dividing -- coming out -- there is nothing Furthermore, once the phenomenon happened, it could not solve positively, either, but the user could not but look at the picture, and it had to be coped with by performing recovery action of a nozzle suitably etc. Moreover, the once confused picture is unrestorable.

[0033] 5) As a trouble in cure 2c, although ink still remains in the ink cartridge or the recording head according to cure 2c, since it will exchange for a new ink cartridge or a new recording head and most quantity of ink is thrown away among the ink which was contained in the ink cartridge after all, without being used for record, a running cost becomes high.

[0034] Therefore, it is reducing the amount of waste ink by the reserve regurgitation, this invention being made in view of the trouble in an above-mentioned each set policy, and maintaining a good image recording state. Reduction of a running cost, a raise in the life of a heater, and reduction of power consumption, The non-regurgitation can attain improvement in the throughput of image recording and according to the ink wetting of a delivery further, It aims at offer of the ink-jet record method and ink-jet recording device which can prevent picture degradation by the sudden unusual regurgitation produced during the image recording by the unusual regurgitation by contaminant plugging of a nozzle, \*\*\*\*\*, etc., the ink piece, etc.

[Means for Solving the Problem] According to this invention, a foam is made to generate in ink by supplying energy in ink from an energy generation element, in order to solve the technical problem mentioned above and to attain the purpose. In the ink-jet recording device which records on the non-record medium which is made to breathe out ink and counters from a recording head with the pressure then generated An acoustic signal detection means to detect the acoustic signal generated from the aforementioned foam, and the discharge-condition judging equipment which judges the discharge condition of ink from the acoustic signal detected by this acoustic signal detection means, By controlling record operation based on the discharge condition of the ink obtained by this discharge-condition judging equipment After detecting generating of discharging only the ink thickened in the nozzle, and the sudden non-regurgitation under record operation and recovering a recording head suitably at the time of the reserve regurgitation or ink substitution, it becomes possible to resume printing from the pixel which the abnormalities in the regurgitation produced.

[0035] The amount of waste ink is reduced by this, maintaining a good image recording state. Reduction of a running cost, A raise in the life of a regurgitation heater, reduction of power consumption, and improvement in the throughput of image recording are attained, And it becomes possible to prevent picture degradation by the sudden unusual regurgitation produced during the image recording by the unusual regurgitation by the non-regurgitation by the ink wetting of a delivery, contaminant plugging of a nozzle, \*\*\*\*\*, etc., the ink piece, etc., and to maintain an always proper image recording state. Moreover, it becomes possible to exhaust ink to the last simultaneously with it.

[0036]

[Embodiments of the Invention] With the operation gestalt of this invention, it is alike and are attached to below, and are an example of application to the ink-jet recording device of BJ method, and an attached drawing is referred to about the printer of the serial recording method which scans a recording head perpendicularly to the transfer direction of a record medium-ed. It is the appearance [ which describes the case where it applies to the reserve regurgitation ] perspective diagram drawing 1 indicated the outline composition of the whole recording device to be first. Recording head 1D which carries out

the regurgitation of the color ink of black to recording head 1C which carries out the regurgitation of the color ink of cyanogen to recording head 1B which carries out the regurgitation of the color ink of a Magenta to recording head 1A to which 1A carries out the regurgitation of the color ink of yellow is installed. Recording heads 1A, 1B, 1C, and 1D are installed on the carriage 2 driven in the direction of an arrow in drawing. Moreover, these recording heads 1A, 1B, 1C, and 1D make one the ink hold section used as the source of supply of each ink, and serve as a disposable type.

[0037] Carriage 2 is guided by the guide shaft 3 prepared in a non-illustrated base, and is moved to right and left of the direction of both arrows, and as the move position is always detected by the encoder 4, it is constituted so that the synchronization with a recording head 1 may be taken. On the other hand, it is sent in the direction of an arrow, the record form (record medium-ed) 5 being guided with two or more delivery rollers 6 installed up and down, and in the platen position used as the ink delivery forming face (a regurgitation side is only called hereafter) of recording heads 1A, 1B, 1C, and 1D, and the position which counters, it is held so that those regurgitation sides and parallel may be faced.

[0038] Next, the composition of recording heads 1A, 1B, 1C, and 1D is explained according to drawing 3 which is the appearance perspective diagram of the recording head 1 of drawing 2, and the cross-sectional view of drawing 2. In these drawings, it explains on behalf of one of two or more above-mentioned recording heads 1.

[0039] In drawing 2 and drawing 3, the recording head 1 has composition which unified the head chip 11 and the ink hold section 12. This head chip 11 consists of junction structure of the substrate 13 made from Si, and the top plate 14 made from glass, and two or more deliveries 15 located in a line in the vertical direction (it sets to drawing 3 and is the depth direction) are formed in the regurgitation side side in those joints. These deliveries 15 are open for free passage in one common liquid room 17 with two or more liquid routes 16 which lead separately. Moreover, the mutual wall of two or more liquid routes 16 is formed for example, of ultraviolet-rays hardening resin etc. The common liquid room 17 is opened for free passage in the ink hold section 12 with the tube 18.

[0040] Moreover, the electric thermal-conversion element 19 as two or more regurgitation energy generation elements located for every inside of a liquid route and the wiring which supplies power individually to these are formed in the upper surface of a substrate 13 by membrane formation technology.

[0041] Furthermore, the heating element 20 is arranged in the position from the liquid route 16 in the common liquid room 17 on a substrate 13. This heating element 20 consists of the same film composition as the electric thermal-conversion element 19, and is formed by membrane formation technology like [ wiring ] the case of the electric thermal-conversion element 19. Power (2-3W) of the same grade as being impressed by the electric thermal-conversion element 19 is suitably supplied to this heating element 20 the time for 5 - 7 microseconds, by this energization, a foam generates in the ink in the common liquid room 17, and an acoustic wave occurs.

[0042] On the other hand, the piezoelectric electroacoustic transducer 40 which consists of piezo electric polymers, such as PZT, crystal, a Rochell salt, and a PORIFFUTSU-ized vinylidene, etc. near the heating element 20 is attached by adhesives etc. on the inferior surface of tongue of a substrate 13, and it is constituted so that the acoustic wave generated from the foam generated with a heating element 20 may be detected through a substrate 13.

[0043] Thus, since the attenuation at the time of spreading the inside of an individual is very small, if an acoustic wave is detected through the substrate 13 which is an individual, since the acoustic wave to produce can take the very large acoustic signal intensity detected, detection of an acoustic wave becomes very easy.

[0044] It is the block diagram which connected the recording head 1 of illustration, and amplifier 41 is connected to drawing 2 and drawing 3 to the above-mentioned electroacoustic transducer 40 in this view, and drawing 4 amplifies the output from an electroacoustic transducer 40, and outputs it to a comparator 42. Although the frequency band of the acoustic wave generated with generation disappearance of a foam is a range about several 100Hz - number MHZ, several 100kHz frequency component takes the lead in energy. Therefore, if the sensitivity of an electroacoustic transducer 40 and

the frequency band of amplifier 41 are in the range of about several 100Hz order, they can be detected by sufficient intensity.

[0045] Although the output from a comparator 42 usually serves as ground potential, if the output from amplifier 41 exceeds predetermined reference voltage, fixed voltage will be outputted to discharge-condition judging equipment 45. When judged with having become normal while this discharge-condition judging equipment 45 outputted the reserve regurgitation continuation signal, when an ink discharge condition was judged based on the output signal of a comparator 42 and it was judged with a discharge condition having not been normal, a reserve regurgitation stop signal is outputted.

[0046] It connects with the recording head drive circuit 44, and according to the signal from discharge-condition judging equipment 45, suitably, record motion-control equipment 43 is constituted so that the drive of a recording head 1 may be controlled.

[0047] In the above-mentioned composition, according to record data etc., power generates heat individually by being supplied alternatively, film boiling will arise in the ink in a liquid route 16, and, as for the electric thermal-conversion element 19 in each liquid route 16, ink will be breathed out by the heat energy from a delivery 15 with generation of the foam by the film boiling.

[0048] And doing in this way and making ink breathe out alternatively from two or more deliveries 15, by moving carriage 2, on the record medium 5-ed, the drop of ink is made to adhere and various image information is recorded. Moreover, in the case of this operation gestalt, a multicolor color picture can be formed by making it adhere on the record medium 5-ed in order of the drop of the yellow from four recording heads 1A, 1B, 1C, and 1D, a Magenta, cyanogen, and the ink of black.

[0049] Next, if the state where it does not record continues more than a predetermined time, record motion-control equipment 43 will start reserve discharging in a non-record section. That is, when non-recording operating state continues predetermined time, record motion-control equipment 43 makes the foam in a liquid route 16 generate by supplying power and making it generate heat to the electric thermal-conversion element 19 through the recording head drive circuit 44. Then, it is begun on the outside of a delivery 15 to breathe out the ink in a liquid route 16 with the pressure of the generated foam.

[0050] However, at the time of this reserve discharging, evaporation of the volatile component in ink has already progressed, and the viscosity of the ink in a liquid route 16 is high unusually. Therefore, ink is very unmovable only at low speed, and the elapsed time to growth of a foam - disappearance becomes very late compared with the case where ink is usually viscosity. Consequently, time after a foam grows until it disappears becomes long.

[0051] It is the output voltage which amplified the acoustic signal with which the horizontal axis was detected by time and the vertical axis was detected [ in / the graph of drawing 5 (a) / drawing 5 is the chart having shown the detection result of the acoustic signal generated with cellular generation - disappearance, and ] by the electroacoustic transducer 40 with amplifier 41, and was obtained. Moreover, drawing 5 (b) is drawing having shown the situation of the output voltage Vdet of a comparator. And drawing 6 shows a control flow chart.

[0052] First, in drawing 5 , the detection peak of the acoustic signal which the inside Pn of drawing generated with cellular generation is shown, and the detection peak of the acoustic signal which Pc generated with cellular disappearance is shown. Moreover, although Vth shows the threshold voltage in a comparator 42 and the output of a comparator usually has ground potential, if the voltage which exceeds Vth in a comparator 42 is inputted from amplifier 41, a comparator will output voltage Vdet, and if input voltage is less than this, it is made to return to ground voltage. Consequently, to a signal as shown in drawing 5 (a), two pulses corresponding to Pn and Pc will be outputted.

[0053] In the above composition, if judged in the case where control is indicated and the printer is not used over the long period of time, and Step S1, energization to the above-mentioned electric thermal-conversion element 19 or an above-mentioned heating element 20 will be performed, generation and disappearance of a foam will be performed, and ink will be breathed out. After amplifying generation of the foam detected by the electroacoustic transducer 40 at this time, and the acoustic signal in the case of disappearance with amplifier 41 and obtaining output voltage, it is judged whether it is more than the

output voltage  $V_{th}$  of amplifier 43, and in being the following, it judges that ink viscosity is normal and shifts to normal record operation.

[0054] Moreover, if it is judged that it is more than the voltage  $V_{th}$ , it will progress to step S4. The detection peak  $P_n$  of the acoustic signal generated with cellular generation and the detection peak  $P_c$  of the acoustic signal generated with cellular disappearance are detected. In Step S5, the time interval  $T_{nc}$  of two pulses is measured by the  $T_{nc}$  measuring circuit. at Step S6 Since time if comparison with  $T_{nc}$  at the time of the normal ink regurgitation which has measured measured  $T_{nc}$  beforehand by the  $T_{nc}$  comparator circuit (the following,  $T_{nc0}$ ) is performed and ink thickens, after a foam will generate by the above-mentioned reason until it disappears becomes long It judges whether it is  $T_{nc0} < T_{nc}$ , and comes out so, and, in a certain case, the reserve regurgitation is continued, and in being  $T_{nc}$ , discharge-condition judging equipment 45 judges that the regurgitation is performed in the state where the ink viscosity in a liquid route is higher than predetermined viscosity, and discharges the thickening ink in a liquid route outside.

[0055] That is, the signal of reserve regurgitation continuation is outputted to record motion-control equipment 43. When a reserve regurgitation continuation signal is received from discharge-condition judging equipment 45, the control unit 43 of record operation supplies power to the electric thermal-conversion element 19, makes this generate heat, and makes a foam generate in a liquid route 16 through the recording head drive circuit 44 again. And discharge-condition judging equipment measures  $T_{nc}$  again, and compares with  $T_{nc0}$ . When it is still  $T_{nc0} < T_{nc}$ , discharge-condition judging equipment takes out a reserve regurgitation continuation signal (Step S7). When repeat the ink regurgitation,  $T_{nc}$  measurement, and comparison of  $T_{nc}$  and  $T_{nc0}$ , the hyperviscous ink in a liquid route is discharged outside gradually, it fills up with the ink of predetermined composition gradually and a time interval  $T_{nc}$  approaches  $T_{nc0}$  in Step S8, It becomes almost equal to  $T_{nc0}$  in the place where the inside of a liquid route was mostly filled up with the ink of predetermined composition.

[0056] At this time, discharge-condition judging equipment outputs a reserve regurgitation stop signal to record motion-control equipment. Record motion-control equipment will suspend supplying power to an electric thermal-conversion element through a record drive circuit, if a reserve regurgitation stop signal is received.

[0057] Performing the above operation about each liquid route 16, record motion-control equipment ends reserve discharging in the place where  $T_{nc}$  in all liquid routes became almost equal to  $T_{nc0}$ .

[0058] Thus, even when there is a difference in the grade of evaporation of the volatile component of the ink for every environmental variation or liquid route, it becomes possible to carry out the regurgitation only of the ink which each liquid route thickened certainly. Consequently, maintaining a good image recording state, the amount of waste ink by the reserve regurgitation is reduced, and reduction of a running cost, raise in the life of a heater, and reduction of power consumption can be realized.

[0059] Moreover, even if resumption of record operation will be a time of time having seldom passed since the last reserve discharging if the above-mentioned reserve discharging is performed in case the reserve regurgitation is performed just before a recording start, only the thickening ink which should be discharged is made to breathe out and record operation can be started immediately. Consequently, time after the signal of a record operation start is inputted until it actually starts image recording can be shortened, and the throughput of image recording will improve.

[0060] Furthermore, it can apply also to the reserve regurgitation performed during record operation which was stated also as the above-mentioned cure 2, and it becomes possible to raise the throughput of a picture. Namely, in case the regurgitation history of each nozzle is made a note of and carried out during record operation, record operation is interrupted when the nozzle which does not make predetermined-time unusual ink breathe out occurs, and the reserve regurgitation is performed in a record section-ed Even when environmental variation differs from a regurgitation history and the grades of thickening of ink differ in each nozzle, it becomes possible to carry out the regurgitation only of the thickening ink which should be discharged in each nozzle, and the time of the reserve regurgitation can be shortened and it becomes possible to resume record operation immediately.

[0061] of course, reserve \*\*\*\* in front of the above-mentioned recording start and record -- working

reserve \*\*\*\* -- it cannot be overemphasized that reduce the amount of waste ink by reserve \*\*\*\* in the case of which, and reduction of a running cost, raise in the life of a heater, and reduction of power consumption are realized

[0062] Next, drawing 7 is the chart having shown the principle judged by on-the-strength change of the acoustic signal which generates the judgment of the normality of a discharge condition, and abnormalities at the time of defoaming. Drawing 7 (a) shows the acoustic signal detected when air bubbles were made to generate and ink \*\*\*\* was performed into the normal ink of predetermined composition, and drawing 7 (b) is the acoustic signal detected when ink \*\*\*\* was performed from the thickened ink. A horizontal axis is time, both vertical axes are voltage, and Pn and Pc are the detection peak of the acoustic signal generated in the cellular generate time, and the detection peak of the acoustic signal generated at the time of defoaming, respectively.

[0063] \*\*\*\*\* -- the threshold voltage Vth in a comparator will return to ground potential, if input voltage is less than this while a comparator will output voltage Vdet to discharge-condition judging equipment 45, if the voltage exceeding Vth is inputted into a comparator, although it usually has ground potential

[0064] On the other hand, if ink viscosity increases, passage resistance will become large and the speed by which ink runs will become slower at the time of hypoviscosity. Therefore, defoaming speed becomes slow and the impulse force generated at the time of defoaming declines. Consequently, the acoustic signal generated at the time of defoaming becomes weak, and as shown in drawing 7 (b), Peak Pc serves as a value smaller than Pn in normal predetermined ink.

[0065] Therefore, if Vth is set as the somewhat low level of Pn in normal ink as shown in drawing 7 (a) and (b) and the regurgitation will be performed proper by composition almost predetermined in ink, Vdet will be outputted, the viscosity of ink is high, and if the regurgitation is not performed proper, the output voltage Vdet of a comparator is no longer outputted. And if Vdet is inputted, a reserve regurgitation stop signal will be taken out and Vdet will not be inputted, it is made for discharge-condition judging equipment to output a reserve regurgitation continuation signal. Therefore, since a discharge condition can be judged by judging whether it becomes unnecessary to have calculated Tnc as mentioned above in this case, and Pn only exceeded Vth, there is an advantage that control is easy and ends.

[0066] Moreover, after the above-mentioned control having detected the non-regurgitation during record operation, performing recovery action after memorizing the position which the non-regurgitation generated, and making it return to a normal discharge condition, printing can be resumed from the pixel corresponding to the image data which started the non-regurgitation.

[0067] The acoustic signal which the life time of a foam becomes long since the ink to an electric thermal-conversion element - a delivery is heavy in order to remain without the ability breathing out ink when near a delivery wets wet in ink even while the ink in a nozzle does not thicken but breathing out in the proper state, the trap of the regurgitation ink is carried out to this and it becomes the non-regurgitation, and defoaming speed falls, and is further generated at the time of defoaming becomes weak.

[0068] Therefore, the acoustic signal accompanying the cellular generation from each nozzle - disappearance is always detected during record operation, and in spite of having made ink breathe out by the time interval to which thickening does not advance, when detected Tnc becomes long unusually or Pn becomes small, it can be judged that the non-regurgitation occurred.

[0069] For this reason, in the block diagram shown in drawing 8 , whether the regurgitation's always having been normally performed from each nozzle during record operation by the method of the above [ discharge-condition judging equipment 45 ] and the non-regurgitation judge whether it is under generating. And when it is judged that the regurgitation was performed normally, a record operation continuation signal is outputted to record motion-control equipment 43, and when it is judged that the non-regurgitation occurred, a record operation stop signal is outputted to record motion-control equipment 43.

[0070] On the other hand, record motion-control equipment 43 will drive a recording head 1 through a

recording head drive circuit according to the image data from an image memory 46, if a record operation continuation signal is received from discharge-condition judging equipment 45. Moreover, when the record operation stop signal was received, after memorizing the image data position which the non-regurgitation generated to non-regurgitation detection position-memory equipment 47, a recording head 1 is evacuated even to a non-picture field, and recovery action is performed.

[0071] The delivery side of a recording head is specifically wiped with a flexible member, and the ink adhering to the delivery side is removed. Then, after performing the reserve regurgitation and checking the normal ink regurgitation in a front nozzle by the above-mentioned method, printing is resumed from the position of the image data which the non-regurgitation memorized by non-regurgitation detection position-memory equipment 47 generated.

[0072] Thus, even if the non-regurgitation occurs suddenly during record operation according to this invention, it becomes possible to maintain a proper image recording state, without degrading a picture.

[0073] Moreover, this invention becomes possible [ maintaining a proper image recording state ], without degrading a picture by carrying out proper management suitably, when it can detect about other abnormalities in the regurgitation under record operation and abnormalities occur in each case.

[0074] For example, in order that a foam may not generate even if it supplies power to an electric thermal-conversion element when ink has been lost during record operation, an acoustic signal does not occur.

[0075] Therefore, it can judge that ink was lost, if an acoustic signal is not detected even if it performs an electric power supply during record operation, and record operation can be interrupted in the stage, and warning can be taken out to a user. And after a user makes ink supply, record operation is resumed and printing can be started from the pixel corresponding to the image data which ink was not made to go out and breathe out. Thus, according to this invention, it becomes possible to exhaust ink to the last, maintaining a proper image recording state.

[0076] In the time when the viscosity of the ink in a nozzle is high, and the time of a low, since the process of growth of a foam - disappearance changes, a different acoustic signal is generated. time (life time of the following and a foam) since passage resistance is specifically strong when the ink viscosity in a nozzle is high, after the process of growth of a foam - disappearance comes out slowly and a foam generates until it disappears becomes long. Moreover, the impulse force which defoaming process generates slowly at the time of hatchet defoaming becomes small, and the acoustic signal generated in connection with it also becomes small.

[0077] Therefore, after detecting the acoustic signal generated with cellular generation, by measuring on-the-strength change of the acoustic signal which measured time (this is equivalent to life time of foam) change until it detects the acoustic signal generated with cellular disappearance, or was generated in connection with defoaming shows viscosity change of ink. Therefore, according to this invention, real time understands viscosity change of the ink in a nozzle, and it turns out whether discharged completely whether thickening ink was still in the middle of eccentric, and the ink in a nozzle changed into the proper state. Consequently, when only thickening ink is made to breathe out in each nozzle, it becomes possible to stop the reserve regurgitation.

[0078] Moreover, while the ink in a nozzle does not thicken but breathing out in the proper state, when the following sudden abnormalities in \*\*\* arise, too, the growth - defoaming process of the generated air bubbles changes, and the acoustic signal to generate also changes. that is, when non-\*\*\*\* by the ink wetting near 1 delivery occurs, in order to remain without the ability breathing out ink, the ink to a heater - a delivery is heavy, and defoaming comes to be alike slowly. Consequently, the life time of air bubbles becomes long and the acoustic signal generated at the time of defoaming becomes weak.

[0079] 2) Since a foam stops generating even if it supplies energy to a heater, when an ink piece happens during record operation, an acoustic signal is no longer detected at all.

[0080] Therefore, after detecting the acoustic signal generated with cellular generation, by measuring on-the-strength change of the acoustic signal which measured change of time (this is equivalent to the life time of a foam) until it detects the acoustic signal generated with cellular disappearance, or was generated in connection with defoaming shows whether the ink regurgitation was performed normally.

therefore -- according to this invention -- record -- even when it was working, when the abnormalities in the regurgitation of ink can be detected on real time and abnormalities are detected, it becomes possible to perform recovery operation of a recording head And since the image data position from which the abnormalities in the regurgitation were started is detectable, after recovering a recording head suitably, it also becomes possible to restore the pixel which failed in proper printing. Moreover, since picture degradation cannot be caused but ink can be exhausted completely, a running cost falls sharply.

[0081] In addition, although especially this invention explained the print equipment of the method which it has [ method ] meanses (for example, an electric thermal-conversion object, a laser beam, etc.) to generate heat energy as energy used in order to make the ink regurgitation perform, and makes the change of state of ink occur with the aforementioned heat energy also in an ink-jet recording method, according to this method, it can attain the densification of record, and highly minute-ization.

[0082] About the typical composition and typical principle, what is performed using the fundamental principle currently indicated by the U.S. Pat. No. 4723129 specification and the 4740796 specification, for example is desirable. Although this method is applicable to both the so-called on-demand type and a continuous system On the electric thermal-conversion object which is especially arranged corresponding to the sheet and liquid route where the liquid (ink) is held in the on-demand type case By impressing at least one driving signal which gives the rapid temperature rise which corresponds to recording information and exceeds film boiling Since make an electric thermal-conversion object generate heat energy, the heat operating surface of a recording head is made to produce film boiling and the foam in the liquid (ink) corresponding to this driving signal can be formed by 1 to 1 as a result, it is effective. A liquid (ink) is made to breathe out through opening for regurgitation by growth of this foam, and contraction, and at least one drop is formed. If the shape of a pulse form is carried out, since growth contraction of a foam will be appropriately performed instancy in this driving signal, the regurgitation of a liquid (ink) excellent in especially responsibility can be attained, and it is more desirable.

[0083] As a driving signal of the shape of this pulse form, what is indicated by the U.S. Pat. No. 4463359 specification and the 4345262 specification is suitable. In addition, if the conditions indicated by the U.S. Pat. No. 4313124 specification of invention about the rate of a temperature rise of the above-mentioned heat operating surface are adopted, further excellent record can be performed.

[0084] The composition using the U.S. Pat. No. 4558333 specification and U.S. Pat. No. 4459600 specification which indicate the composition arranged to a delivery which is indicated by each above-mentioned specification as composition of a recording head, the liquid route, and the field to which the heat operating surface other than the combination composition (a straight-line-like liquid flow channel or right-angled liquid flow channel) of an electric thermal-conversion object is crooked is also included in this invention. In addition, it is good also as composition based on JP,59-138461,A which indicates the composition whose opening which absorbs the pressure wave of JP,59-123670,A which indicates the composition which makes a common slot the regurgitation section of an electric thermal-conversion object to two or more electric thermal-conversion objects, or heat energy is made to correspond to the regurgitation section.

[0085] Furthermore, any of the composition which fills the length with the combination of two or more recording heads which are indicated by the specification mentioned above as a recording head of the full line type which has the length corresponding to the width of face of the maximum record medium which can record a recording device, and the composition as one recording head formed in one are sufficient.

[0086] In addition, you may use the recording head of the exchangeable chip type with which the electric connection with the main part of equipment and supply of the ink from the main part of equipment are attained, or the recording head of the cartridge type with which the ink tank was formed in the recording head itself in one by the main part of equipment being equipped.

[0087] Moreover, it is a book to add the recovery means against a recording head established as composition of the recording device of this invention, preliminary auxiliary means, etc. It is effective in order to perform record stabilized by performing reserve regurgitation mode in which the preheating means by the capping means, the cleaning means, the pressurization or the suction means, the electric thermal-conversion object, the heating elements different from this, or such combination over a

recording head and the regurgitation different from record are performed, if these are mentioned concretely.

[0088] Furthermore, by constituting not only the recording mode of only mainstream colors, such as black, but a recording head in one as a recording mode of a recording device, even with two or more combination, although it is good, it can also consider as equipment equipped with full color at least one by the double color color of a different color, or color mixture.

[0089] In this invention example explained above, although ink is explained as a liquid Even if it is ink solidified less than [ a room temperature or it ], you may use what is softened or liquefied at a room temperature. Or by the ink-jet method, since what carries out a temperature control is common as a temperature control is performed by within the limits below 70 degreeC more than 30 degreeC for ink itself and it is in the stable regurgitation range about the viscosity of ink, ink should just make the shape of liquid at the time of use record signal grant.

[0090] In addition, in order to prevent positively by making the temperature up by heat energy use it positively as energy of the change of state from a solid state to the liquid state of ink, or in order to prevent evaporation of ink, you may use the ink which solidifies in the state of neglect and is liquefied by heating. Anyway, ink liquefies by grant according to the record signal of heat energy, and this invention can be applied when using the ink of the property liquefied for the first time by grant of heat energy, such as that by which liquefied ink is breathed out, and a thing which it already begins to solidify when reaching a record medium. In such a case, ink is good for a porosity sheet crevice or a breakthrough which is indicated by JP,54-56847,A or JP,60-71260,A also as liquefied or a gestalt which counters to an electric thermal-conversion object in the state where it was held as a solid. In this invention, the most effective thing performs the film-boiling method mentioned above to each ink mentioned above.

[0091] Furthermore, in addition, as a gestalt of the recording device concerning this invention, although prepared in one or another object as the picture outgoing end end of information management systems, such as a computer, you may take the gestalt of the reproducing unit combined with others, the reader, etc., and the facsimile apparatus which has a transceiver function further.

[0092] A foam is made to generate in ink by supplying energy in ink from an energy generation element. In the ink-jet recording device which records on the record medium-ed which is made to breathe out ink and counters from a recording head with the pressure then generated An acoustic signal detection means to detect the acoustic signal generated from the foam, and the discharge-condition judging equipment which judges the discharge condition of ink from the acoustic signal detected by this acoustic signal detection means, By controlling record operation based on the discharge condition of the ink obtained by discharge-condition judging equipment After detecting generating of the sudden non-regurgitation under discharging only the bottom ink of thickening in a nozzle, and record operation and recovering a recording head suitably at the time of the reserve regurgitation or ink substitution, it becomes possible to resume printing from the pixel which the abnormalities in the regurgitation produced. The amount of waste ink is reduced by this, maintaining a good image recording state. Reduction of a running cost, A raise in the life of a regurgitation heater, reduction of power consumption, and improvement in the throughput of image recording are attained, And it becomes possible to prevent picture degradation by the sudden unusual regurgitation produced during the image recording by the unusual regurgitation by the non-regurgitation by the ink wetting of a delivery, contaminant plugging of a nozzle, \*\*\*\*\*, etc., the ink piece, etc., and to maintain an always proper image recording state. Moreover, it becomes possible to exhaust ink to the last simultaneously with it.

[0093] In addition, even if it applies this invention to the system which consists of two or more devices, you may apply it to the equipment which consists of one device. Moreover, this invention cannot be overemphasized by that it can apply when carrying out by supplying a program to a system or equipment. In this case, the storage which stored the program concerning this invention will constitute this invention. And it operates by reading the program from a storage to a system or equipment depending on how which a system or equipment was beforehand defined and carries out.

[Effect of the Invention] By reducing the amount of waste ink by reserve \*\*\*\*, maintaining an image

recording state with good abnormalities according to this invention, as explained above Reduction of a running cost, a raise in the life of a heater, and reduction of power consumption, Non-\*\*\*\* can attain improvement in the throughput of image recording and according to the ink wetting of a delivery further, The ink-jet record method and ink-jet recording device which can prevent picture degradation by sudden unusual \*\*\*\* produced during the image recording by unusual \*\*\*\* by contaminant plugging of a nozzle, \*\*\*\*\*, etc., the ink piece, etc. can be offered.

[0094]

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[Translation done.]

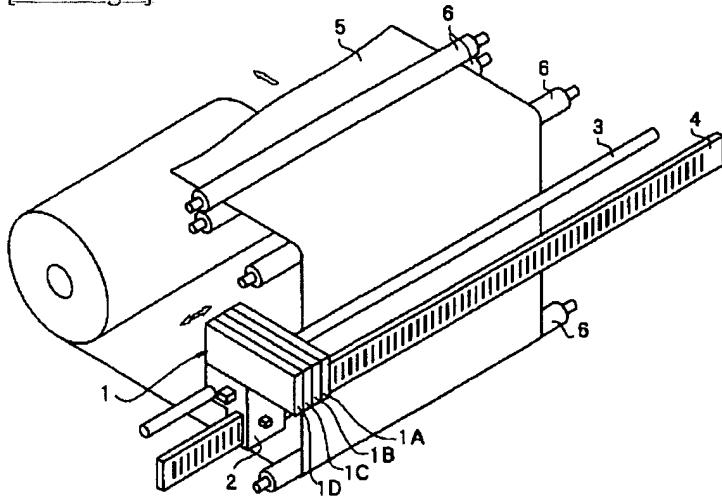
## \* NOTICES \*

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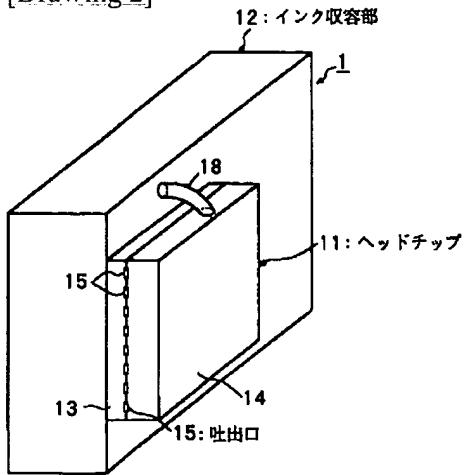
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

## DRAWINGS

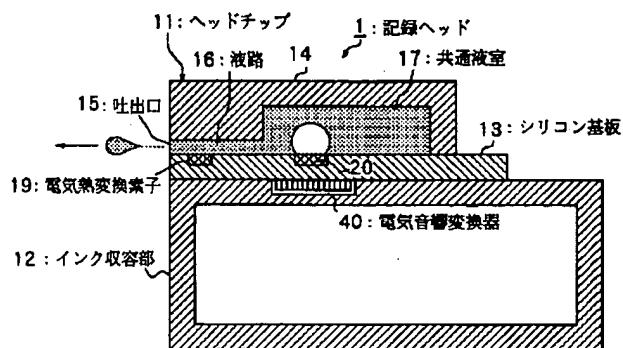
[Drawing 1]



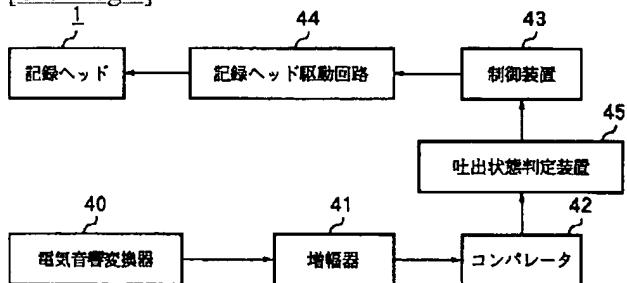
[Drawing 2]



[Drawing 3]

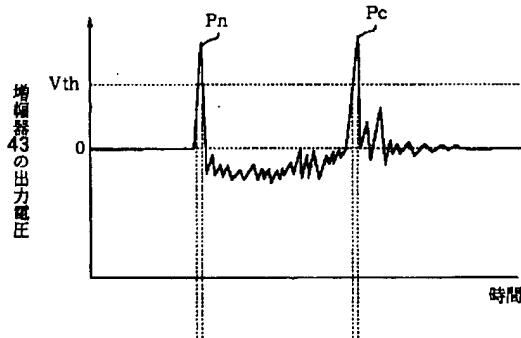


[Drawing 4]

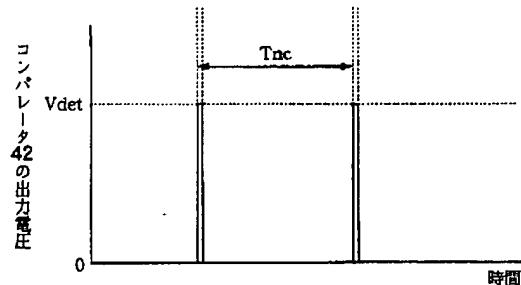


[Drawing 5]

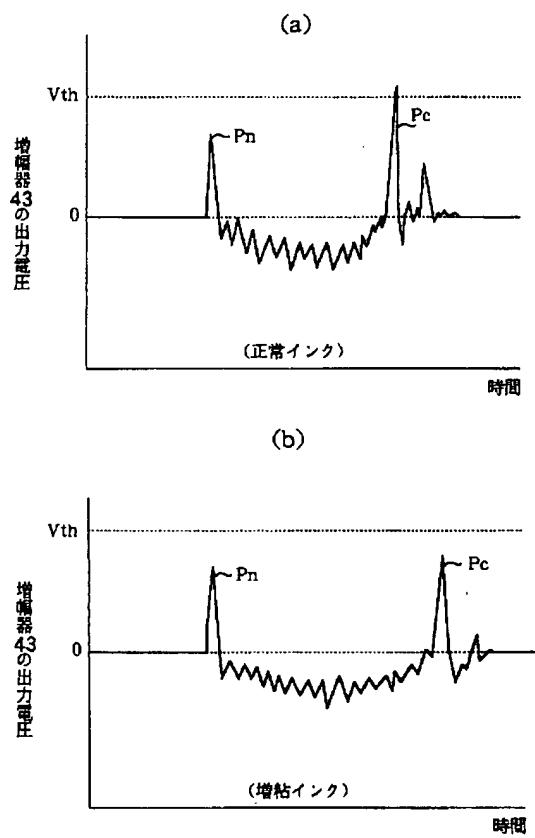
(a) (a)



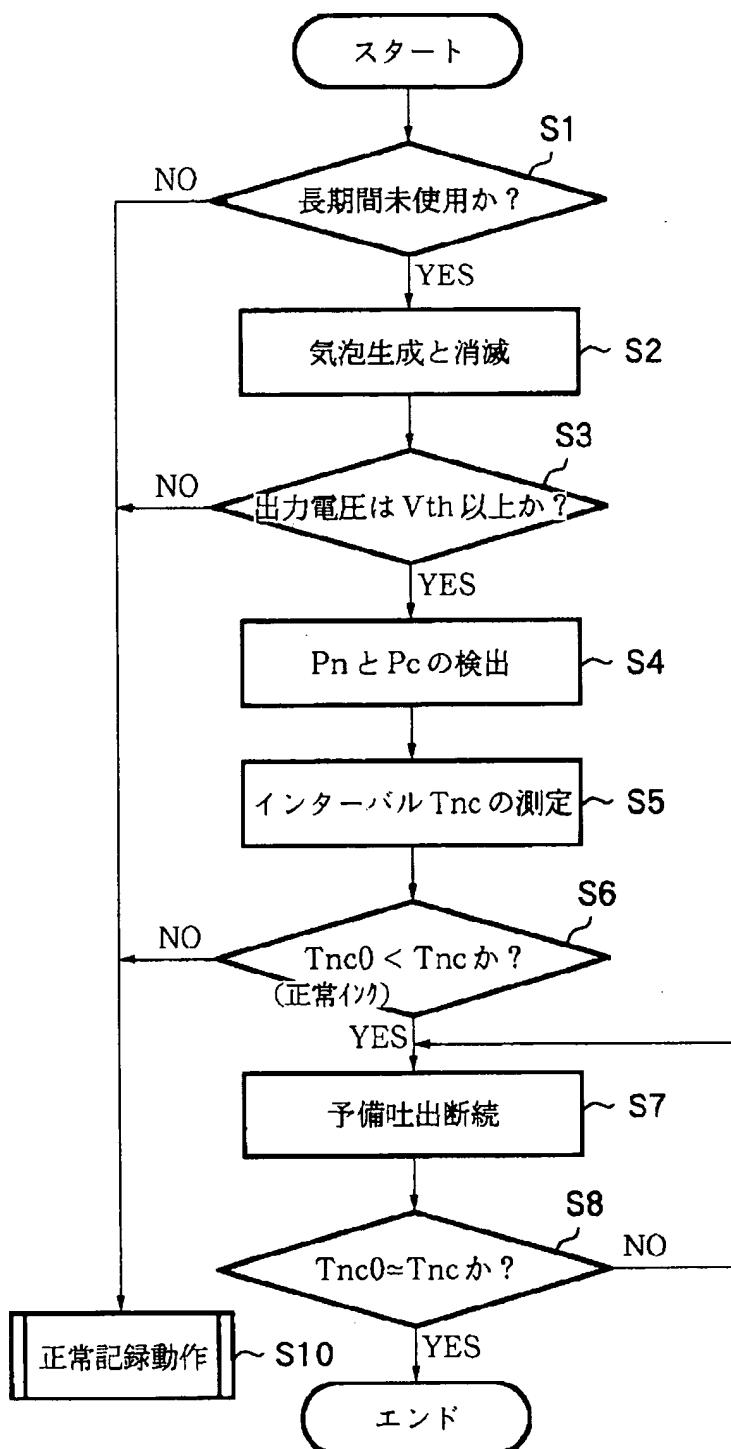
(b)



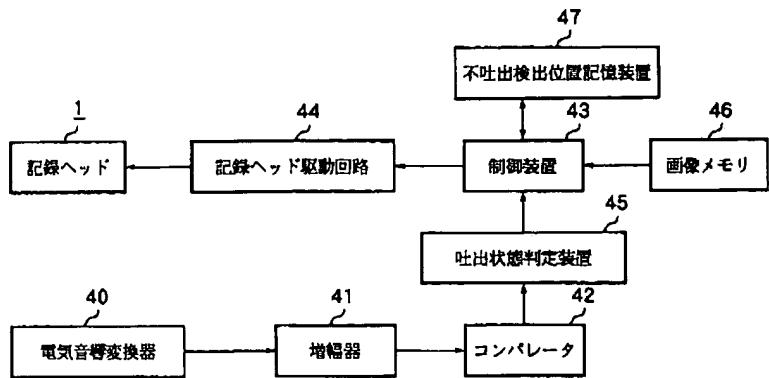
[Drawing 7]



[Drawing 6]



[Drawing 8]



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[Translation done.]